

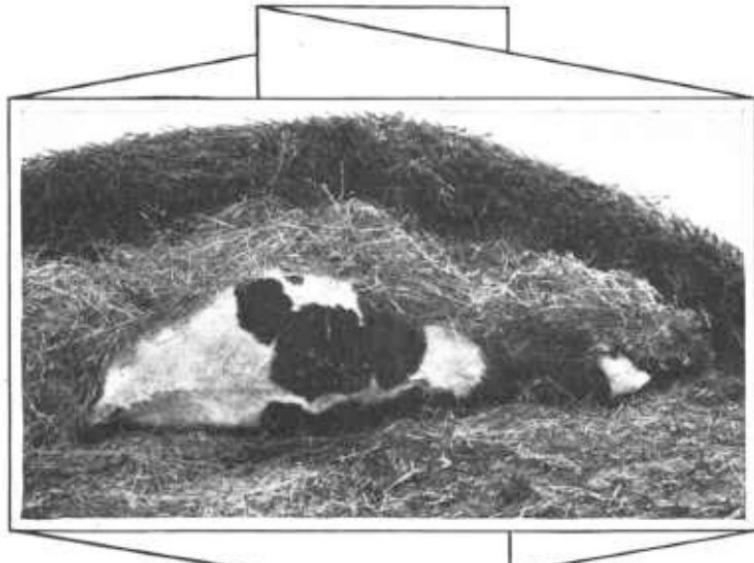
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ANTHRAX



ANTHRAX is an infectious disease of livestock caused by a germ that exists in the soil of certain regions which are known as "anthrax districts." Such districts exist in practically all countries where livestock is raised.

Practically all species of livestock are susceptible to this disease, which is transmissible also to man. Cattle, horses, and sheep are most commonly affected and develop the disease in the acute form, with a resulting high death rate. Hogs acquire the disease for the most part in a chronic form from which they frequently recover.

The infection is taken in principally with feed and water, but the germ may also gain entrance through the skin and respiratory tract. Once in the body, the germs multiply rapidly; after death every drop of blood contains myriads of the disease-producing organisms.

The symptoms vary according to the species of animal affected and the acuteness of the attack. Sudden death occurs frequently among horses, cattle, and sheep. In addition to high temperature and labored breathing, cattle, horses, and mules commonly have doughy swellings beneath the skin, and frequently there are bloody exudates from the natural openings. Sheep most often have convulsions before death. In hogs swelling of the throat is the most common symptom.

A greatly swollen, dark, soft spleen, dark, tarry, poorly coagulating blood, hemorrhages, and watery infiltrations are the principal evidences of anthrax.

Control measures on anthrax-infected premises consist in prompt disposal of carcasses by cremation or deep burial, preventive vaccination, and wherever practicable, the fencing of badly infected lands and water holes. Roving dogs, carrion-eating birds, and flies should be controlled so far as possible.

When the course of the disease is not too rapid, antianthrax serum has a specific curative effect. So far as is known no other treatment is effective.

The control of anthrax is a major concern of the livestock industry. Consult and cooperate with your local veterinarian and livestock sanitary officials.

This bulletin supersedes Farmers' Bulletin 784, Anthrax or Charbon.

ANTHRAX

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INTRODUCTION

ANTHRAX is an infectious disease of livestock caused by a specific micro-organism or germ known as the anthrax bacillus (*Bacillus anthracis*) and characterized in its most common form by a rapidly fatal course or by sudden death. The disease causes annual losses of many millions of dollars to the livestock industry. As it is also infectious to man, anthrax is a menace to public health.

SUSCEPTIBILITY OF ANIMALS

Practically all animals are susceptible in some degree to anthrax, but the herbivorous animals are most susceptible. Cattle, horses, sheep, goats, and wild herbivorous animals are most commonly affected, and in these animals the disease usually appears in the acute form which rapidly terminates in death.

Although hogs are susceptible to anthrax, they possess a resistance to the disease greater than that shown by the other species of domestic livestock. In hogs a relatively high percentage of affected animals recover.

Dogs and other carnivorous animals may become infected by eating the carcass of an animal dead of anthrax. Poultry, however, is not susceptible to the disease under ordinary conditions.

Anthrax is infectious to man also, being contracted through the handling of anthrax-infected carcasses, hides, wool, or hair and manifesting itself as a local infection of the skin or as an infection of the respiratory or digestive tracts. In the latter forms, the disease spreads rapidly throughout the body and terminates in death.

CAUSE OF THE DISEASE

Anthrax is caused by a specific micro-organism or germ which is indigenous to the soil in certain areas wherein it survives for long

periods, especially in areas that are subject to periodic inundations or in low-lying marshy land.

These organisms in their active state (vegetative forms) are cylindrical in shape and grow in the presence of air. When they gain access to the animal body they multiply rapidly and invade the blood stream, producing a rapidly fatal blood infection or septicemia (fig. 1).

When these cylindrical rods are released from the animal body they produce, on access to the air, elliptical bodies known as spores, which are very resistant to heat, cold, drying, and exposure to disinfectants. In the soil these spores may live for years, ready to reproduce the disease in susceptible animals that may come in contact with them (fig. 2).



FIGURE 1.—Photomicrograph of blood from a sheep that died of anthrax, showing the cylindrical anthrax bacilli in their active state. The more or less round objects are blood corpuscles. Magnified about 500 diameters.

in 1850 by the French investigator, Davaine, who later (1865) showed their causal relationship to the disease, anthrax. In 1876 the German investigator, Robert Koch, cultivated the anthrax bacillus outside the animal body on an artificial culture medium.

GEOGRAPHICAL DISTRIBUTION AND SEASONAL OCCURRENCE

Anthrax is widely distributed, having appeared on every continent. Before the disease was known to be of an infectious nature and before systematic measures were taken to suppress it, heavy losses were sustained in many countries.

Being a disease indigenous to the soil, anthrax is more or less confined to certain districts, where it occurs almost every year; such areas are commonly designated as "anthrax districts." In such districts the disease makes its appearance during a more or less definite period of the year, usually in the summer, such periods being referred to as the "anthrax season." Isolated cases, however, may occur at any time, including the winter months when stock is not on pasture.

Since anthrax-contaminated soil is the source of the disease in livestock, most outbreaks occur when the animals are on pasture. It has been observed that hot, dry summers with scant growths of pasture, necessitating grazing close to the soil, are frequently followed by

HISTORY

Although in all probability anthrax existed in very early times and acquired its name through the dark color of the blood of its victims, its nature was unknown until 1836 when its infectiousness was established through the transfer of the disease from one animal to another by inoculation and feeding the diseased blood.

The specific rod-shaped microscopic germs were first observed in the blood in 1849 by the German investigator, Pollender. The micro-organisms were also observed

unusually large numbers of cases of anthrax. Likewise, a period of rainy weather followed by warm days appears to favor the occurrence of the disease. It is also a well-known fact that heavy losses from anthrax often follow in the wake of floods and periodic inundations of low-lying land.

In certain years the disease assumes a very virulent form, appearing simultaneously at a number of places, new centers of infection occurring in rapid succession, and soon it covers large areas, occasioning heavy losses of livestock. The cause of these cyclic waves is as yet unknown.

MODES OF INFECTION AND DISSEMINATION

It is generally considered that anthrax infection for the most part occurs by way of the digestive tract. Spore-laden soil is taken in with the feed principally while the animal is on pasture, although hay made on anthrax-contaminated lands may harbor virulent spores and cause the disease in stable-fed animals.

Contaminated drinking water is also a potent source of infection. Water may become contaminated through the surface drainage of anthrax lands or from the carcasses of animals that died of anthrax, especially when they lie close to or in an upper branch of a stream or in a pond.

Infection may also occur by way of the skin through anthrax spores from the soil lodging in wounds and abrasions or through punctures made by biting insects that had previously fed on a diseased animal. It is possible that anthrax organisms may penetrate the unbroken skin, reach the deeper structures, and set up infection. Such evidence has already been obtained in human cases at least. Infection may also take place through the respiratory tract, the inhaled spores setting up a rapidly fatal form of pneumonia. This form of anthrax is recognized in man more often than in the lower animals.

As previously stated, soils contaminated with anthrax frequently remain dangerous for long periods, requiring only favorable climatic and moisture conditions to cause repeated outbreaks of the disease and the consequent reinfection of the land. Additional territory may in turn become contaminated through the wandering of diseased animals, which spread the germs with their excreta as they go and finally contaminate new land heavily with the countless numbers of micro-organisms that escape from the natural openings of their dead bodies.

Dogs and other carnivores, as well as the carrion-eating animals and birds, are potential spreaders of anthrax from one area to another. After feeding on an anthrax-infected carcass their bodies

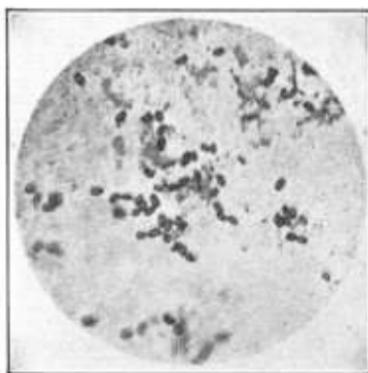


FIGURE 2.—Photomicrograph of anthrax culture showing the resistant elliptical anthrax spores. Magnified about 500 diameters.

doubtlessly are heavily contaminated with anthrax spores and these may be carried to distant fields. Virulent anthrax spores were found, in an experiment, in the droppings of buzzards that previously had fed on an anthrax-infected carcass.

Some of the flying insects must be considered as potential spreaders of anthrax, feeding as they do on the blood of living animals or on the materials that escape from the natural openings. Animals sick of anthrax become easy prey to myriads of flies and other insects, both biting and nonbiting. Virulent anthrax organisms have repeatedly been found in or on the bodies of several species of flies, including blowflies taken from carcasses of animals dead from anthrax (fig. 3). Entomologists have shown that some of these flies and other insects travel great distances.

Streams contaminated with surface drainage from anthrax-infected land or by carcasses of animals dead of anthrax may convey the



FIGURE 3.—Carcass of a cow dead of anthrax. Note the great number of flies on the carcass. Virulent anthrax germs were found on flies taken from this and one partly incinerated carcass on the same ranch. (Photograph by W. G. Bruce, Bureau of Entomology, U.S. Department of Agriculture.)

germs many miles downstream, infecting the territory through which they pass.

Anthrax may spread from one country to another through the interchange of infected hides, hair, wool, bone meal, fertilizer, forage, and other items closely related to animal life.

The Government endeavors to prevent the introduction of this disease into the United States through the administration by the Bureau of Animal Industry of regulations governing the sanitary handling and control of hides, skins, fleshings, hide cuttings, parings, glue stock, hair, wool and other animal by-products, and hay and straw of foreign origin.

SYMPTOMS

According to the course of the disease, anthrax is recognized in three forms: A peracute form, in which the interval between the first

outward manifestation of symptoms and death is but a few hours or even minutes; an acute form, in which the disease lasts for a day or two; and a subacute form, in which the period between first symptoms and death or recovery extends beyond several days.

In the peracute form of the disease, death occurs so quickly that clinical symptoms are seldom observed. In the great majority of instances animals that when last seen were apparently in perfect health are found dead. Less often a seemingly healthy animal is seen to fall to the ground, go through a few convulsive movements, and die. Closer examination frequently shows blood-stained discharges from the nose, mouth, and anus. Peracute anthrax occurs most often in the beginning of an outbreak among cattle and is the most common form of the disease in sheep. Sudden death in cattle, sheep, and horses in areas where anthrax previously existed should always be viewed with suspicion and the owner should be on the lookout for anthrax.

In cattle, in addition to the peracute form of the disease in which few symptoms are seen, acute and subacute infections develop. In these forms there is first a stage of excitement, which is soon followed by depression. In this stage the animal lags behind, with the head hanging low, refuses to eat, and prefers to stand still or to lie down. Respiration is more rapid than normal and appears to be labored. Rumination ceases, and in milking cows the milk secretion is materially lessened. Pregnant animals may abort. At this stage of the disease the body temperature is elevated and may reach 180° F. Bloody discharges usually come from the natural body openings. When diarrhea sets in, the feces are usually blood-tinged. Small hemorrhages may be noted on the visible mucous membranes. Soft swellings that pit on pressure may develop over the body, but the more common sites are about the external genitalia and on the lower wall of the abdomen. The tongue also may show extensive swelling and dark discoloration.

Shortly before death respiration becomes extremely labored, the mucous membranes take on a bluish cast, and the temperature falls below normal.

In horses and mules, the first indication of disease may be severe colicky symptoms accompanied by the passage of blood-stained feces. Hot, painful, and rapidly progressing swellings frequently develop over the body, especially about the neck, lower abdomen, and external genitalia. Hemorrhages may be seen on the visible mucous membranes. There is loss of appetite and elevation of the body temperature.

In sheep and goats, anthrax occurs most often in the peracute form. Either the animal is found dead or dies shortly after the first symptoms are noted. The visible symptoms are unsteady gait, trembling, restlessness, difficult respiration, bloody discharges from the natural openings, blueness of the mucous membranes, and convulsions preceding death.

In hogs, when infection follows feeding on an anthrax-infected carcass, some of the animals may be found dead, not having shown any previous signs of illness. Others of the group may show symptoms of illness with rapidly progressing swellings about the throat, these swellings in some cases causing death by suffocation. A relatively large percentage of the group may become visibly sick

for a few days, with or without moderate swellings about the throat, and recover. When hogs develop anthrax from sources other than feeding on anthrax-infected carcasses, the above-mentioned symptoms are observed, except that sudden death without visible symptoms is rare.

In dogs affected with anthrax, swellings may occur about the head and throat.

In man, anthrax usually occurs as a primary localized infection of the skin in the form of a carbuncle or as an infection of the lungs known as "woolsorter's disease." In countries where the flesh of animals dead of disease is eaten, an abdominal form of anthrax has been reported.

Skin infections result from the handling of carcasses of animals dead of anthrax or the hides, hair, or wool from such carcasses. Originating as localized infections in the form of small pimples, the lesions develop rapidly and may terminate in a fatal septicemia or blood poisoning. Prompt medical attention is most important whenever anthrax infection is suspected.

The pulmonary form of the disease results from the inhalation of anthrax spores in factories where hair and wool are processed. The course of this form of anthrax is very rapid and terminates fatally.

ANATOMICAL CHANGES

If anthrax is suspected, the stockman should consult a veterinarian at once rather than open up a carcass for the purpose of making a definite diagnosis. The seriousness of such a mistake can hardly be overestimated owing to the greatly increased danger of spreading the disease when the body is opened and discharges from it escape. Post-mortem examination in suspected cases of anthrax should be made only by a qualified veterinarian who is prepared to take all necessary precautions against infecting himself and the premises.

Carcasses of animals dead of anthrax decompose rapidly and soon become greatly bloated. The natural post-mortem stiffening of the muscles is incomplete. Dark blood escapes as a rule from the natural openings, and the visible mucous membranes are dark blue in color and frequently show hemorrhages. The blood is considerably darker than normal, does not clot readily, and is frequently spoken of as being tarry. Hemorrhages beneath the skin are common. Clear or somewhat blood-tinged gelatinous exudates are found between the muscles and beneath the skin, especially in the areas where the swellings were seen before death.

With rare exceptions the spleen shows characteristic changes, which are of considerable assistance in making a diagnosis of anthrax. This organ is greatly enlarged, and the splenic pulp is dark red to blackish in color and soft, or even semifluid in consistency.

The liver and kidneys are congested and enlarged and frequently show areas of hemorrhage on their surfaces. The heart muscle is grayish red and flabby. The lungs are congested and contain serum. The mucous membranes of the trachea and bronchi are red and dotted with hemorrhages of varying sizes. The mucous membrane of the intestines is greatly swollen and hemorrhagic.

In hogs the outstanding anatomical changes are confined principally to the region of the throat, where there is a marked gelatinous and hemorrhagic condition of the connective tissues and lymphatic glands. The tonsils are enlarged and frequently covered with a dark, discolored false membrane. Swelling of the structures forming the glottis is also observed. Although the spleen is frequently normal in size and color, enlarged, dark, and soft spleens may be found in cases where the disease has become generalized.

Local lesions of long standing are sometimes found in the throat region of slaughtered hogs that had shown no visible signs of anthrax during their life and which were apparently healthy prior to slaughter. In these cases the disease is confined to the pharynx and the adjacent tissues including the lymphatic glands of that region. Localization of anthrax in the mesenteric glands has also been observed. In this chronic localized type of anthrax the lymph glands of the head, especially the submaxillary glands, may be either slightly or greatly enlarged, hard, and fibrous. The cut surface presents a mottled appearance, being produced by areas which are brick red in color, patches or streaks having a dull gray, parboiled appearance and necrotic foci which may be dry and cheesy. One or both tonsils may show areas of degeneration and necrosis ranging in size from that of a pinhead to that of a silver dollar. The epiglottis may be greatly swollen (fig. 4).

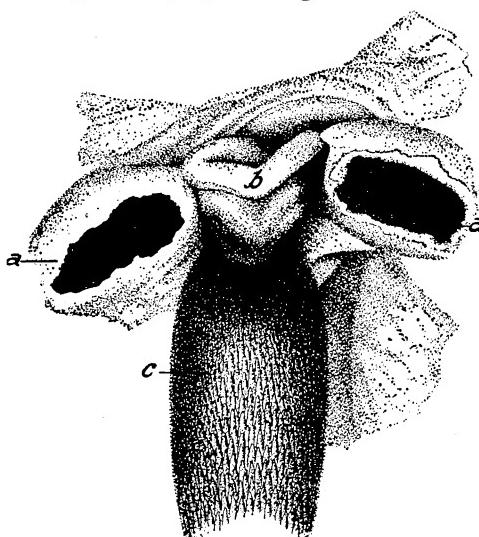


FIGURE 4.—*a*, Ulcerated tonsils of a hog affected with the chronic form of anthrax. The other organs shown are epiglottis *b* and tongue *c*.

DIAGNOSIS

When an animal dies within an anthrax district or on or near premises where the disease has appeared previously, it is very important to know definitely whether the death was due to anthrax. Lack of such information has often been responsible for heavy losses of livestock and, at times, the loss of human lives. Whenever there is a possibility of anthrax, it is advisable to have the cause of death determined by a competent veterinarian. If local veterinary service is not available the State livestock sanitary officials should be consulted.

The diagnosis of anthrax from clinical symptoms may at times be difficult, especially when the disease occurs at a time when it is not prevalent and on premises that have formerly been free from

the infection. In peracute anthrax, death is so sudden and the clinical symptoms are so meager that a definite diagnosis is impossible without the aid of laboratory examination. Cerebral hemorrhage, sunstroke, lead poisoning, or some acutely fatal digestive disturbance may be confused with peracute anthrax especially if it occurs in the so-called anthrax districts.

In the less acute cases of anthrax, there may be an escape of bloody exudate from the natural openings, together with swellings beneath the skin. However, somewhat similar swellings are observed in malignant edema, hemorrhagic septicemia, tick fever, and sweetclover poisoning of cattle and purpura hemorrhagica in horses. Although swellings are found in blackleg of cattle, such swellings crackle under pressure because of their air content and are readily distinguishable from the gasless swellings of anthrax that have a doughy consistence and pit on pressure. In all of the above diseases, with the possible exception of malignant edema, blood-stained discharges may at times be seen. In hogs, malignant edema involving the throat region may be mistaken for anthrax, and a definite diagnosis can be made only by laboratory examination of some of the affected tissues.

Any previous occurrence of anthrax on the premises is sufficient reason for considering anthrax as a possible cause of any deaths among livestock that cannot be clearly attributed to other causes. In a large number of such instances a tentative diagnosis of anthrax can be substantiated by laboratory examination. When a laboratory examination is desired, suitable specimens should be collected by a qualified veterinarian. In case professional services are not available and the samples are to be collected by others, the greatest care should be taken by the operator to prevent infecting himself. Heavy rubber gloves should be used to prevent the infectious material from coming in contact with the hands.

A few drops of blood deposited in a small wide-mouthed bottle or jar and the container rolled around so as to spread the blood in a thin film that will dry quickly on the bottom or side walls makes a very satisfactory specimen for bacteriological examination. Larger quantities of blood are unsatisfactory in that putrefaction may set in and destroy any anthrax organisms that may be present. Furthermore, the forwarding of larger quantities of such blood by common carrier is a dangerous procedure which should not be undertaken. The few drops of blood that are required may be collected from a small cut made over the jugular vein or at the base of the ear immediately before the carcass is buried or cremated.

Another method of obtaining a specimen, but a less satisfactory one, is as follows: Remove an ear, place it in a tight container and pack it in a strong box for shipment to the laboratory. As in the case of large quantities of blood, however, there is danger of putrefaction setting in.

After the samples are collected, it is advisable to destroy the operating knife with the carcass and thoroughly disinfect the hands and arms with a solution of 1 part bichloride of mercury to 1,000 parts of water. This solution should be mixed in and used from a wooden bucket or stoneware crock. As this disinfectant, if swal-

lowed, is very poisonous to man and animals, precautions should be taken accordingly.

No attempts should be made by the layman to collect specimens of the internal organs. The body cavities should be opened only by an experienced veterinarian who is able to protect himself and the premises should the animal's death be due to anthrax.

CONTROL MEASURES

Anthrax is a menace to the livestock industry and requires the concerted defensive action of livestock sanitary officials, local veterinarians, and owners. When the disease threatens or invades one's herd, it is advisable to obtain the assistance of a qualified veterinarian or State official, who is in a position to advise intelligently on the most effective means of control.

The first line of defense against anthrax consists of the prompt and proper disposal of animals dead of the disease.

The second line of defense is vaccination for prevention or cure in accordance with methods recommended by livestock sanitary officials and other experienced veterinarians.

The third line of defense consists in fencing, wherever practicable, to exclude livestock from pools, swamp land, and pastures where anthrax infection is known to exist.

DISPOSAL OF CARCASSES AND DISINFECTION

In the control of anthrax prompt and effective disposal of carcasses is of greatest importance. It is good practice to dispose of all animal carcasses properly, especially in an anthrax area, even though the possibility of anthrax may at the time seem remote. This can be accomplished either by complete cremation or deep burial under a layer of quicklime covered with at least 6 feet of earth. Carcasses should not be buried in low swampy land or adjacent to streams where overflow might inundate the grave, or on a hillside where there is a possibility of subsurface drainage reaching the surface at lower places nearby. The area above and around the grave should be saturated with oil and burned over. The method to be employed will be governed by the prevailing weather conditions and the relative promptness and ease with which each procedure can be carried out at the place where disposal becomes an issue.

In disposing of a dead animal the following method is recommended: Immediately after finding the animal, cover it with kerosene or crude oil to keep flies, dogs, buzzards, crows, and vermin from the carcass until it is disposed of. If conditions permit, cremate or bury the carcass where it is found. If moving to a more suitable site is necessary, take the greatest care to prevent any discharges or hair from contaminating the soil over which the carcass is moved. Consequently, never permit a carcass to be dragged. A stone boat or sled may be used as a means of conveyance. Thoroughly disinfect or burn any equipment used in moving anthrax-infected carcasses. Avoid actual contact with the germ-laden body; this can be done through the use of properly applied ropes and poles, which may then be burned. Prepare a solution of bichloride of mercury

to disinfect the hands and boots or shoes of the operator after the disposal of the carcasses has been completed.

It is advisable, if possible, to have the disposal of anthrax-infected carcasses conducted under the supervision of a qualified veterinarian who from experience can advise on the most effective and economical means of destroying the carcass and disinfecting whatever materials may have become contaminated by the animal or carcass.

The cremation of the carcass of a sheep or hog is not difficult, but the complete destruction of that of a horse or cow is more of a problem. There are several methods that give satisfactory results in the cremation of large carcasses. One of these is to dig two trenches approximately 2 feet wide and 18 inches deep, crossing each other at right angles, over which a grating of green posts is laid, followed by several layers of dry rails or split logs. After the carcass is placed on this pyre, straw and either kerosene or oil are used to start a good fire. Additional fuel is added as needed. A covering of sheet iron or green logs tends to conserve the heat and hasten the destruction of the carcass.

Another method requires no trenches. Oil is applied freely to the carcass, which is then covered with a liberal quantity of straw, and this in turn is covered with a thick layer of heavy, moderately dry manure. Burning the straw generates sufficient heat to start the manure burning, which continues slowly until the carcass is reduced to ashes. This method, which is shown in part on the cover page, is slower than the one which involves the use of a rail pyre. There should be plenty of oil, straw, and manure, and the carcass should be fully covered.

When anthrax is prevalent, it is advisable for the owner to keep all his own dogs tied up and to discourage in every possible way stray dogs from coming on the premises. There is always a possibility of such animals having eaten of an anthrax carcass and so becoming spreaders of the infection.

For the same reason action should be taken to protect livestock from the dangers of buzzard and crow roosts. Protection from flies and biting insects so far as practicable is advisable also.

When anthrax occurs in stabled animals, prompt and thorough disinfection of the quarters should follow the removal of the dead animals. Where sick animals are being treated, every precaution should be taken to prevent spread of the infection through contaminated excreta. There is always a possibility of rats or mice transferring contamination to the hayloft or feed storerooms. Therefore special effort should be made in anthrax districts to get rid of these pests.

Of the disinfectants, lye is one of the most effective. For disinfection of premises against anthrax, a 5-percent solution is recommended. To prepare such a solution $2\frac{1}{2}$ pounds of commercial lye containing 94 percent of sodium hydroxide is dissolved in $5\frac{1}{2}$ gallons of water. Where a whitewash is not objectionable, water-slaked (not air-slaked) lime may be added to the lye solution in the proportion of $2\frac{1}{2}$ pounds of lime to each $5\frac{1}{2}$ gallons of lye solution for the purpose of preventing the transformation of the active principle, sodium hydroxide, into sodium carbonate, which is considerably less effective as a germicide. It is advisable to use the lye or lye-and-lime solution as soon as it is prepared. All places to be

disinfected should be thoroughly soaked with the disinfectant, which should be allowed to remain on for at least a day and should then be thoroughly washed off with clean water before the livestock are returned.

Manure from a stable where deaths from anthrax have occurred should be burned or deeply buried or, if this is impracticable, disinfected with very liberal applications of a 5-percent solution of lye. However, it is questionable whether any reasonably heavy applications of lye solution would disinfect completely large quantities of manure. It is impossible, therefore, to make general recommendations on the disposal or disinfection of manure that would be efficient and practicable under all conditions. Methods of procedure, therefore, should be left to the judgment of a qualified veterinarian.

PREVENTIVE VACCINATION

Where anthrax appears more or less regularly each year, vaccination affords the best means of holding the losses to a minimum.

Proper immunization against anthrax is a highly technical problem that involves an understanding of the principles of immunity, as well as expert knowledge of the available immunizing agents, the nature of each product, the immunizing value of each, and its limitations. Anthrax vaccination is, therefore, a procedure that should be under the immediate supervision of a qualified veterinarian.

Where vaccination is necessarily an annual procedure, it should be performed in advance of the anthrax season or at least before anthrax makes its appearance. There is a possibility that vaccination may be followed by an initial state of lowered resistance preceding the establishment of immunity, and exposure to anthrax during this period of increased susceptibility may prove costly. In fact, field observers have frequently witnessed the rapid development of cases of anthrax within several days after vaccination when it was performed after the disease had started. This, it was believed, could have been avoided had the vaccination been performed before the outbreak occurred.

It should be borne in mind, however, that vaccination is not 100 percent effective regardless of the method of vaccination or the vaccine that is used. It is not uncommon for anthrax to develop in an occasional animal even when it is vaccinated with an anthrax biologic that apparently affords protection to the rest of the herd. Whether this is due to the failure of the individual to respond properly to vaccination or whether that particular animal picked up a sufficient number of anthrax spores to break down any degree of immunity cannot be determined. In experimental work in which a number of similarly vaccinated animals are given identical exposures to anthrax, the occasional loss of a properly vaccinated animal seems to point to the failure of the particular individual to respond properly to the vaccination that was given rather than to a fault in the vaccine.

With the knowledge that anthrax vaccination is not 100 percent effective an occasional loss from anthrax in a vaccinated herd does not constitute grounds for questioning the value of the biologic that was used; neither does it justify hasty revaccination of the herd.

The following varieties of anthrax-immunizing agents are now available in the United States: Antianthrax serum, anthrax ag-

gressin, anthrax antigen, anthrax bacterin, antianthrax serum and anthrax-spore vaccine, single-injection anthrax-spore vaccine (in liquid or pill form), double- or triple-injection anthrax-spore vaccine (in liquid or pill form), anthrax-spore vaccine (intradermic), anthrax-spore vaccine in saponin solution. The first four of these comprise the sterile anthrax products and the remainder the living-spore anthrax products.

The selection of the anthrax biologic to be used on a given lot of animals should be left to the local veterinarian or State livestock sanitary officials who, because of their experience and knowledge of the local conditions, are in a position to know which products are best suited to the needs of the herd.

STERILE ANTHRAX-IMMUNIZING AGENTS

Antianthrax serum is made from the fluid part of the blood of horses, mules, or cattle that have undergone a process of hyperimmunization to anthrax. This process consists in beginning with injections of small quantities of weakened anthrax cultures, followed by a number of injections both larger in quantity and of increased virulence, until the animal can withstand enormous doses of virulent anthrax culture. By this means the blood serum of the hyperimmunized animal becomes heavily charged with anthrax-immune bodies. When such serum is collected, properly preserved, and stored it will retain its potency for several years. The serum contains no living micro-organisms or spores.

Antianthrax serum injected into animals (fig. 5) produces increased resistance to anthrax as soon as it is absorbed, and the resistance is in direct proportion to the quantity of serum that is given. It is of value both as a preventive and as a curative agent. The immunity which it confers, however, is of relatively short duration. Under experimental conditions the serum afforded complete protection at 4 days after its administration, but 16 days after vaccination the protection was reduced by one-half.

As a preventive, therefore, the use of antianthrax serum is advisable when immediate protection is the principal object even though the immunity is but temporary. When serum alone has been given to the apparently healthy animals in an infected herd, it should be followed 10 days later by vaccination with a biologic that will produce a more enduring immunity.

Anthrax aggressin, anthrax bacterin, and anthrax antigen differ from antianthrax serum in that they stimulate the treated animal to produce immune bodies (active immunity), whereas the serum treatment is merely a mechanical transference of already produced immune bodies to the treated animal (passive immunity). Naturally the protection afforded by aggressin, bacterin, or antigen would not become established as early as that established with serum, but it would be of longer duration. These three products, being sterile, are in themselves incapable of producing disease in the treated animal and are, therefore, safer than the living-spore anthrax vaccines.

LIVING-SPORE ANTHRAX PRODUCTS

All anthrax-spore vaccines are composed of living anthrax spores and are prepared in either liquid or solid form (pellets). These

products may be used alone or in combination with antianthrax serum. The spores in these vaccines are so weakened that under ordinary conditions they will not produce the disease in livestock, if the vaccines are administered according to directions. However, a few individual animals are unusually susceptible and may react severely to vaccination with these spore vaccines, and occasionally an animal may die as a direct result of the vaccination (vaccination anthrax). For this reason, it is ordinarily inadvisable to use living-spore anthrax vaccines on premises where the disease has not existed previously or where there is reason to believe that previous infections have died out.

When these living-spore vaccines are used to control anthrax the greatest care should be taken to prevent contamination of the soil



FIGURE 5.—Vaccinating a cow to produce immunity against anthrax.

with the vaccine. Although the spores have been weakened, there is no definite assurance that they may not, under favorable soil conditions, again return to a virulent state and establish a new center of infection. Thorough disinfection of the restraining chute and the floor or ground where the vaccination was performed and prompt disposal of the empty vaccine containers by burning are recommended.

Experience has shown that the living-spore vaccines produce a higher degree of immunity than do the sterile anthrax and as a rule vaccination with any of the living-spore vaccines used either alone or in combination with serum, is followed by an active immunity which lasts sufficiently long to carry the animal through the usual anthrax season. However, in some years anthrax makes its

appearance in a highly virulent form, and in these years the artificial immunity which can be produced by vaccination does not always protect against infection.

FENCING AND OTHER CONTROL MEASURES

The third line of defense against anthrax consists of appropriate measures to prevent the introduction of the infection on anthrax-free premises and keeping livestock off the most dangerous parts of infected premises.

The principal concern of owners of anthrax-free premises is to prevent the introduction of the infection. Although the disease can be introduced through means which are beyond man's control, every effort should be made to guard against possible introduction by needless or faulty vaccination with living-spore anthrax vaccines, roaming dogs, especially when anthrax is prevalent in the vicinity, and the use of hay, straw, or other forage originating on premises where anthrax infection is known to exist. Livestock should also be protected from the potential dangers of buzzard and crow roosts. This can to a certain extent be accomplished by fencing off a small area about each tree containing a buzzard or crow roost.

Thorough inspection of premises where outbreaks of anthrax have occurred may disclose pools or marshlands that are potential sources of infection. Such places, as well as parts of pasture lands known to be heavily infected, should be fenced off so far as is practicable, since vaccination may fail to produce an immunity which is strong enough to protect against the heavy exposure that might be acquired in such heavily infected places.

TREATMENT

When the progress of the disease is not too rapid, treatment with large doses of antianthrax serum administered by a qualified veterinarian is frequently successful. When used either as a preventive or as a curative there is no danger of giving an overdose of the serum, but there is a possibility of giving quantities which are insufficient to accomplish their purpose. No other known product, drug, or combination of drugs can be depended on to cure an established case of anthrax in animals.

INDIVIDUAL RESPONSIBILITY AND COOPERATION

From both an economic and public-health standpoint, anthrax is a dreaded disease against which every means of suppression needs to be exerted. The suddenness with which anthrax strikes, the heavy toll that it takes, the long life of the infection in the soil, and the many ways in which the disease may be spread, make the problem of control a common cause to which every livestock owner should be a contributor. To this end, all persons concerned are in duty bound to put into effect every known measure of combating the disease and to cooperate to the fullest extent with the local veterinarian and livestock sanitary officials who are charged with the responsibility of controlling diseases of livestock.